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CAUDAL ANAESTHESIA VERSUS SPINAL ANAESTHESIA- INTRAOPERATIVE AND POSTOPERATIVE PROFILE IN PAEDIATRIC SURGICAL PATIENTS

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INTRODUCTION
The history of paediatric anaesthesia and analgesia is fascinating, in terms of the enormous advancement that has taken place, from the days when block techniques and equipment for adults were adapted for use in children. Since then, significant developments have occurred regarding general anaesthesia (GA), regional anaesthesia (RA) and perioperative pain management in the paediatric population.

Regional anaesthesia and analgesia techniques provide a combination of excellent anaesthesia and pain relief, minimal side-effects and high patient satisfaction. Caudal block and epidural block, first described in paediatrics by Meredith Campbell in 1933 and Roderie Sievers in 1936 respectively for cystoscopies, have now become the most commonly used RA techniques in paediatric practice.[1,2] In 1900, Bainbridge performed spinal anaesthesia in a 3 months old infant. These techniques have a short learning curve, with an extensive safety record. The use of neuraxial catheters has circumvented the disadvantage of short duration of action after single injection.[3]

While the landmark-guided approach to central neuraxial blocks is time tested, simple, and easy to perform, it is prone to block failure due to anatomical variations.[4,5,6] The advent of fluoroscopy and ultrasound has markedly improved the first attempt success rates of these techniques with less complications, although few studies reported a longer block time with ultrasound compared to the conventional technique.[7,8] However, learning the central neuraxial blocks with landmark guided technique is extremely important given the fact that all centres may not be equipped with modern equipment like fluoroscopy and ultrasound.

Although there are studies comparing lumbar and thoracic epidural analgesia in paediatrics[9,10,11,12], an extensive literature search revealed no study comparing the ease of needle insertion in caudal and spinal space (subarachnoid space) in paediatric patients undergoing infraumbilical surgeries. Hence, this study was taken up with an aim to compare caudal and spinal techniques of neuraxial anaesthesia, in terms of the ease of needle insertion, efficacy in providing intraoperative and postoperative analgesia in terms of number of rescue analgesic requirements, haemodynamics, patient satisfaction and complications.

MATERIALS AND METHODS
After obtaining Institutional Human Ethics Committee approval, this prospective observational cohort study was conducted in the department of Anaesthesiology, Sher-I-Kashmir Institute of Medical Sciences, Srinagar, Jammu and Kashmir, India. Sixty patients posted for elective infraumbilical surgeries were recruited between September 2016 and June 2018. Patient information sheet was provided and written informed consent was obtained from the parents of all patients. Assent of the patient was taken if he was 7 years or more in age.

Determination of sample size: Using GPOWER software (v 3.0.10; Franz Faul, Kiel University, Kiel, Germany), it was estimated that the least number of patients required in each group with 80% power, effect size of 0.65 and 5% significance level was 30. Therefore a total of 60 patients were included in our study.

INCLUSION CRITERIA
- Age group- 2-15 years
- Children undergoing elective infraumbilical surgeries
- ASA-1 and II status

EXCLUSION CRITERIA
- Patient / Guardian refusal
- Infection at local site
- Spine deformities

- Raised intracranial tension
- Patients with neurological deficits or psychiatric disorders
- Patients with bleeding disorders or on anti-platelet and anti-coagulant drugs
- Hypersensitivity to local anaesthesia drugs
- Patients with chronic pain syndrome or on pain modifying drugs

All patients underwent routine pre-anaesthetic evaluation a day before surgery and were fasted as per the institutional preoperative fasting guidelines. In the preoperative holding area, premedication (oral midazolam 0.4 mg/kg given 40 min before the procedure) was administered.

Procedure

Drugs were prepared by the anaesthesiologist and equipment necessary for procedure and resuscitation were kept available. Under all aseptic precautions, all blocks were performed in lateral decubitus position with one or both hips flexed, using midline approach. All those blocks were included in the study which were performed by a single anaesthesiologist with > 5 years of experience in paediatric anaesthesia. Patients were divided into 2 groups of 30 each.

Group S (n=30): 0.5% hyperbaric bupivacaine 0.4 mg/kg through subarachnoid space.

Group C (n=30): bupivacaine (volume = 0.1 ml of anaesthetic solution × body weight × number of segments to be blocked) at a dose of 3 mg/kg through caudal space.

The drug doses were based on the desired dermatome blockade as T10 for infraumbilical surgeries and were inferred from a previous study.[13] In order to differentiate between difficult and unsuccessful needle/ catheter insertion, all those patients were excluded in whom the block administration was unsuccessful. Successful block injection was defined as no blood or cerebrospinal fluid on aspiration, injection into the caudal canal without any resistance, no dural tap and no subcutaneous swelling. Such blocks were further classified as easy and difficult. A difficult caudal/ spinal block was defined as a procedure that lasted >100 s or required >10 needle passes.[14] Vital parameters were recorded at induction (baseline), then every 20 min till the end of surgery. After 20 mins of block administration, any increase in heart rate (HR) or Mean arterial blood pressure (MAP) >20% from baseline inspite of a MAC value of 1-1.5, was considered as pain, and hence block failure. Patients with unsuccessful/failed blocks were supplemented with injection fentanyl 1 mcg/kg IV and paracetamol 15 mg/kg IV as analgesia.

Hypotension and bradycardia, defined as 20% decrease from baseline levels, were treated with rapid infusion of intravenous fluids and atropine 0.02 mg/kg IV respectively. Hypotension persisting inspite of fluid administration was treated with ephedrine 0.1-0.2 mg/kg IV. Desaturation was defined as SpO2 < 94% in the perioperative period. After the completion of the surgical procedure, the patients were shifted to the post anaesthesia care unit (PACU). In the post-operative period the following parameters were evaluated for 24 hours of the study duration:

1. **Postoperative vitals** were noted at the time of being shifted to PACU, then at 6 hours, 12 hours and 24 hours.
2. **Patient satisfaction score** was inferred from FLACC (Face, Legs, Activity, Cry, Consolability)[15] score in PACU, at 6 hours, 12 hours and 24 hours postoperatively where

0: meant a relaxed and comfortable patient, represented by “best”

1-3: meant mild discomfort, represented by “good”

4-6: meant moderate pain, represented by “satisfactory”

7-10: meant severe pain or discomfort or both, represented by “poor”

3. **Total no. of top ups received**- At a FLACC Score of > or = 4 in the postoperative period, rescue analgesia of paracetamol 15 mg/kg IV was given.
4. **Complications** related to the procedure or the drugs, were noted in the intraoperative and postoperative period like local anaesthesia systemic toxicity (LAST), haemodynamic instability. Complications like dural puncture and subcutaneous swelling during caudal block, were noted but not analysed.

STATISTICAL METHODS

Statistical software SPSS (version 20.0) was used to obtain the statistics of the data including the mean and standard deviation for numerical variables and the percentages for categorical variables. Student’s independent-test was employed for inter-group analysis of the data. Intra-group analysis was carried out with the help of Paired t-test and Fisher’s exact test. T-test or F-test, whichever appropriate, was used for comparison of categorical variables. Graphically the data was presented by bar and line diagrams. A p-value of less than 0.05 was considered statistically significant. All p-values were two tailed.

RESULTS

The two groups were similar in terms of demographic characteristics like age (p-value of 0.087) and gender (Table/ figure 1). All patients in both the groups were ASA grade I.

On statistical comparison, needle insertion was easy in caudal block compared with spinal block with a p value of 0.037 (Table/ figure 2).

There were no statistically significant differences in baseline heart rate (HR) (p =0.252), mean arterial pressure (MAP) (p =0.091) and oxygen saturation (p =0.165), between the two groups before performing the block, intraoperatively and in the postoperative period (Table /figure 3 and 4). Patient satisfaction scores, based on the FLACC scores and the rescue analgesic requirement, were comparable at all time intervals in both the groups (p value > 0.05) (Table / figure 5,6). None of the patients reported bradycardia in the intraoperative or postoperative period.

Tables/ figures

Table / figure 1: Comparison of patient demographics between the two groups.

	Group L		Group C		P value
VARIABLES	**Mean ± SD**	**N(%)**	**Mean ± SD**	**N(%)**	
Age	8.0000 ± 3.42405		6.5667 ± 2.93238		0.087
Gender Male Female		 18(60.0%) 12(40.0%)		 17(56.7%) 13(43.3%)	

Table / figure 2: Comparison of ease of needle insertion between the two groups.

	Group L	Group C	P value
	N(%)	**N(%)**	
Ease of needle insertion Easy Difficult	13(43.3%) 17(56.66%)	21(70%) 09(30%)	**0.037**

Table/ figure 3: Comparison of heart rate distribution of patients in Group S and group C at different time intervals.

Heart rate	Group S		Group C		F-Test
	Mean	**Standard Deviation**	**Mean**	**Standard Deviation**	**p- value**
Baseline	98.13	9.584	100.07	11.991	.252
20min	90.73	12.259	91.20	10.740	.517
40min	87.80	10.097	92.50	9.843	.436
60min	92.13	7.847	93.90	8.495	.890
80min	87.13	8.456	92.53	9.947	.766
100min	87.47	10.579	91.50	8.195	.124
120min	87.70	9.018	88.40	8.295	.867

Table/figure 4: Comparison of mean arterial pressure (MAP) between Group S and Group C at different time intervals.

MAP	Group S		Group C		F- Test
	Mean	**Standard Deviation**	**Mean**	**Standard Deviation**	**p-value**
Baseline	73.87	3.598	71.10	2.833	.091
20min	71.70	3.905	69.47	3.501	.197
40min	71.43	4.006	69.77	3.401	.193
60min	71.60	3.793	69.53	2.886	.149
80min	71.93	3.290	69.87	2.837	.398
100min	72.53	3.441	69.87	2.623	.163
120min	72.60	3.936	70.67	2.721	.058

Table/ figure 5: Comparison of patient satisfaction between Group S and Group C.

		Group S	Group C	Fisher's Exact test
		N(%)	**N(%)**	**p-value**
PACU	Poor	0(0.0%)	0(0.0%)	
	Satisfactory	12(57.9%)	8(42.1%)	
	Good	17(50.0%)	17(50.0%)	
	Best	1(16.7%)	5(83.3%)	
				0.1808
6HRS	Poor	0 (0.0%)	0(0.0%)	

	Satisfactory	10(50.0%)	10(50.0%)	
	Good	4(44.4%)	5(55.6%)	
	Best	16(51.6%)	15(48.8%)	
				1.00
12HRS	Poor	0(0.0%)	0(0.0%)	
	Satisfactory	3(30.0%)	7(70.0%)	
	Good	1(33.3%)	2(66.7%)	
	Best	26(55.3%)	21(44.7%)	
				0.3737
24HRS	Poor	0(0.0%)	0(0.0%)	
	Satisfactory	14(46.7%)	16(53.3%)	
	Good	4(44.4%)	5(55.6%)	
	Best	12(57.1%)	9(42.9%)	0.7741

PACU- Post Anaesthesia Care Unit, HRS - hours

Table/ figure 6: Number of top ups received in Group S and Group C.

		Spinal	Caudal	Fisher's Exact test
		N (%)	**N (%)**	**p-value**
number of top-ups	one top-up	10(38.5%)	16(61.5 %)	
	two top ups	14(66.7%)	7(33.3%)	
	Three top ups	6(46.2%)	7 (53.8%)	
Mean ± SD		10±2.309	10±0.703	0.15

DISCUSSION

Neuraxial blocks are the gold standard techniques for post-operative analgesia in children. They avoid the side effects associated with administration of intravenous opioids, with studies demonstrating fewer episodes of hypoxemia or respiratory depression and a reduced need for postoperative ventilation and intensive care.[16] There is also better hemodynamic stability, improved gastrointestinal function, less nausea and vomiting and a reduced neurohumoral stress response.[17] The neuraxial anaesthesia and analgesia techniques have been used either as a single shot technique or a continuous catheter technique for infants and young children undergoing abdominal, urologic or orthopaedic surgeries.

A total of 65 patients were enrolled in the present study. The demographic characteristics of patients in both the groups were comparable. There was inability to insert needle in the subarachnoid space in one patient of group S. This was considered as block failure and the patient was excluded from the study. Dural puncture was observed in one patient from Group C during needle insertion. Although excluded from our study, this patient was followed up in the postoperative period. The child did not develop post dural puncture headache. Three patients were excluded from Group C due to subcutaneous swelling. Thus, 60 patients were analysed.

In the present study, the ease of needle insertion in Group C was easier than in Group S (Table/ figure2). In accordance with these findings, Ponde VC et al discussed the recent developments in paediatric neuraxial blocks and stated that, the caudal epidural was technically much easier and safer to practise in intra-abdominal surgeries for intra- and post-operative analgesia.[18] However, Price C M et al found that 93% of lumbar and 64% of caudal epidural injections were correctly placed (p< 0.001), indicating the accuracy of needle placement by the two approaches.[11] Auler Jr JOC et al delineated the ease of localizing sacral hiatus in children younger than 8 years of age or weight lower than 30 kg and observed that above this age, there is a relative difficulty in administering caudal epidural anaesthesia. This difficulty was attributed to progressive sacral ossification and obliteration of sacrococcygeal angle with age, leading to difficulty in identification of the sacral hiatus.[19] This explains the finding of subcutaneous swelling in three patients in the present study. This difficulty can be mitigated by using ultrasound to locate the sacral hiatus and visualise the local anaesthesia deposition in the space.

The incidence of block failure and dural puncture observed in our study was in accordance with those reported by previous studies.[20,21,22,23,24] In a review article by Patel D on epidural analgesia in children, serious or catastrophic complications after caudal block were described as rare (incidence of inadvertent IV injection as 1:10 000, incidence of epidural hematoma/ abscess as 1:80 000). The reported failure rate was 2-10% in caudal block (attributed to abnormal anatomy, inexperienced operator or inappropriate choice of block) and 5% in lumbar epidural block. The incidence of catheter leakage/occlusion and dural tap after lumbar epidural were reported as 11–17% and 0.1–0.5% respectively. Similarly, the incidence of serious or major complications after lumbar epidural (< 1:100 000) in children was described as less than that in adults.[16] Walker BJ et al reported the risk of transient neurologic deficit was 2.4:10,000 and did not report any permanent neurologic damage in any patient. They calculated the risk of severe local anaesthesia systemic toxicity as 0.76:10,000 and reported no haematomas due to neuraxial catheters. This study demonstrated a comparable efficacy of paediatric and adult regional anaesthesia techniques and confirmed the safety of performing the neuraxial blocks.[21]

In the present study, HR and MAP decreased from the baseline values after 20 mins of block administration, indicating effective analgesia achieved by the bupivacaine injections in both the groups. But when they were compared with the other group, the result was not significant (p value >0.05) (table/ figure 3,4). Therefore indicating that both the techniques were comparable in providing effective anaesthesia and analgesia and none was superior to the other. Also, both the techniques had insignificant effect on the haemodynamics of the patient. There was no incidence of hypotension, bradycardia and respiratory depression postoperatively in either group. Various studies support our findings.[10,25,26,27,28] Comparison of the number of top ups in each group revealed statistically insignificant results (table/ figure 6). These findings were in accordance with the findings of numerous studies.[10,29,30,31] Patient satisfaction inferred from FLACC scores was also comparable between the two groups (table/figure 5) at all the time intervals. This finding was similar to that observed by Schnabel et al.[32,33]

After the surgery all children were calm and showed no signs of discomfort. This suggests effective immediate postoperative analgesia, similar in both neuraxial techniques.

Limitations of the study

Firstly, unsuccessful/ failed block was defined separately from difficult block, hence not analysed for incidence. Secondly, our study included a broad range of age, 2 years to 15 years, which makes reliable pain assessment a challenge in different age groups. We therefore suggest more prospective studies with larger sample sizes and with multicentre patient enrolments, to find out the incidence of complications associated with these procedures.

CONCLUSION

Needle insertion is easy in caudal epidural block compared with subarachnoid block in paediatrics. Both the techniques provide comparable quality of analgesia, stable haemodynamics with minimum complications. In settings where ultrasound is available, the safety of needle insertion under anaesthesia may be further improved.

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